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FIELD PERFORMANCE OF PERMISSIBLE ELECTRIC CAP LAMPS

BY

A. B. HOOKER

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

FIELD PERFORMANCE OF PERMISSIBLE ELECTRIC CAP LAMPS[1]

By A. B. Hooker [2]

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INTRODUCTION

Permissible electric cap lamps are used in more than 1,000 mines in the United States, including bituminous-coal mines, anthracite mines, metal mines and salt mines.

All lamps are approved with the understanding that those sold and installed will be made according to the sample lamps that were tested and approved; also that lamps differing from the approved designs will not be marketed or used with approval labels until the changes have been approved by the Bureau.

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[1] The Bureau of Mines will welcome reprinting of this paper provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7188."

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The manufacturers and users of these lamps have cooperated in the approval agreement so that field inspection of lamp installations to determine if they meet the foregoing requirements is unnecessary. Therefore inspections are made by the Bureau's testing engineers chiefly to observe the performance of the lamps under various mining conditions and to correlate that performance with laboratory tests and procedures.

Lamp performance reported in this paper is based upon inspections of lamp installations at 28 mines of 12 operating companies in southern West Virginia. These installations included recent types of standard cap lamps from each of the three manufacturers of permissible electric cap lamps.

Although the mines visited are representative of mines in only one district, field and laboratory experience indicates that the observations and conclusions apply generally to all installations of permissible electric cap lamps.

Conclusions

Satisfactory performance of permissible electric cap lamps implies that the battery electrolyte does not spill and that few lamps fail in service.

There are satisfactory and unsatisfactory installations of every make and type of permissible electric cap lamp.

All unsatisfactory installations could be made satisfactory by changes in supervision and lamphouse procedure for filling, recharging, handling, and repairing the lamps and by enough discipline to insure more careful use of the lamps.

Lamp performance is based chiefly upon the condition of the battery, that is, whether the lamp burns the required length of time. A contract that guarantees light output places emphasis on the whole lamp to insure greater light; therefore, such a contract seems desirable.

Higher-light-diffusing reflectors with light ratios of 15 : 1 to 25 : 1 should replace spot-type reflectors for all but inspection purposes.

LAMPHOUSE OBSERVATIONS

Lamps

The 28 lamp installations represented 5 types of cap lamps of 3 manufacturers, as follows: Types A and B, of manufacturer X; types C and D, of manufacturer Y; and type E, of manufacturer Z. They were distributed as follows:

Type of lamp:	Number of installations	Total number of lamps
A................	9	5,258
B................	5	2,151
C................	1	834
D................	2	800
E................	8	2,790
A and B	1	230 and 30
A, B, and E	1	445, 25, and 75
C and D	1	540 and 132
Total	28	13,409

Kind of Contract

Nineteen of the installations were on rental contracts under which the lamps belong to the lamp company and are rented by them to the mine operating company.

The other nine installations had been upon an ownership-rental basis, by which the lamps had become the property of the renter at the end of 5 years.

Five of the rented installations were on a special contract calling for a guaranteed light output. These contracts were based upon certified initial performance, with the provision that the lamps be replaced whenever periodic tests of fully charged lamps, taken at random from the charge racks, showed a light output of less than 80 percent of the certified performance.

Lampman

The lampman has direct charge of the lamp installation. Whether he works alone or has assistants depends on the size and type of installation. Of the 28 installations visited, 17 had assistant lampmen, 6 had a lampman without an assistant, and 5 had no lampman at all, the lamps being cared for by other employees as their regular work permitted.

The following factors were observed to decrease the lampman's work:

1. A rental contract, under which the lamp company does all repairing and replaces faulty lamps.

2. A parallel system of charging, in which all batteries, when in the rack, are connected to a constant-voltage supply and each battery automatically takes its needed charge.

3. A self-service method of handling the lamps, by which each employee takes his lamp from the rack and returns it to its proper place at the end of his work shift.

4. A system of supervision and discipline, requiring that each employee rack his lamp correctly, use it carefully, and report or indicate any lamp failure to the lampman.

5. The presence of the lampman at each change of shift, so that he may be available to the men for consultation and for minor adjustments of the lamps.

6. Prompt inspection of the racked lamps, to insure that all are charging properly.

The following factors increase the lampman's work:

1. Owned lamps, that usually are acquired after a rented period. These lamps are relatively old and require more repairs and attention than newer lamps.

2. A series system of charging without self-service which requires that each lamp be given out and received by a lampman or assistant and that the batteries have approximately the same discharge before being put back on charge.

3. Lack of discipline which, by permitting careless handling and use of the lamps, results in excessive breakage and lamp repairs.

4. The use of man trips so that the men arrive at the lamphouse in groups, which results in crowding at the lamp racks and excessive breakage of lamps.

5. Unusual bookkeeping, such as recording the working time.

6. Failure to make minor repairs promptly.

The best lamp installations, from the standpoint of the lampman, were upon a rental basis, with self-service and either series or parallel charging. In these installations the lampman, with proper supervision and discipline, used his spare time for inspection and study aimed toward better care and performance of his lamps.

Supervision

The company management may select the make and type of lamps for each of its mines and determine the kind of contract, but supervision of each lamp installation apparently is delegated to the mine superintendent, who has direct authority over all who take care of or use the lamps.

The degree of supervision cannot be observed readily in one visit to a lamphouse, but its absence cannot be mistaken. The following indications were noticed at the mines visited:

Mine 1. - The lampman was an old employee but had no previous lamphouse experience. He seemed to lack natural ability along this line, and the work was difficult and distasteful to him. He was kept on the job in spite of excessive breakage and unsatisfactory performance of the lamps.

Mine 2. - This mine had a self-service installation in which the lampman was unable to cope with the carelessness of the men in racking their lamps and taking each others' lamps. Instead of backing the lampman in maintaining discipline, the supervisor closed the lamphouse to the men and gave the lampman the added work of receiving and giving out the lamps, even though the lamphouse was designed for self-service.

Mine 3. - This mine was one of several that had a self-service installation but no lampman. The lamps were under the care of the hoistmen, each of whom was given a definite number of lamps to service. However, none of the men seemed to be responsible for other equipment in the lamphouse. For example, the charging generators had badly worn commutators. One of the generators had failed on a previous shift through loss of brush contact, and the batteries were only partly charged. The commutator condition still existed, and the impression obtained was that no one was responsible.

Mine 4. - The lampman stated that this installation was owned but was upon a maintenance-rental basis, yet he did unusual repair work, such as soldering lock and hinge hasps, far beyond that observed at any other lamphouse.

Supervision seemed remiss at this mine, as a maintenance-rental contract should have covered such repairs; also a more advantageous use of the lampman's time and added discipline should have prevented much of the lamp breakage and many failures.

Lamphouse Methods

The method employed with any lamp installation depends on several factors, including the kind of lamps, the lamphouse and its equipment, supervision, the lampman, and the mine served. Thus lamp installations and lamphouse methods are never exactly the same.

Charging

In 12 of the 28 installations the parallel system of charging the batteries was employed. All but one of these were self-service installations in which each miner takes his battery off charge and puts it back on charge at the end of the shift and each battery, when charged, remains on trickle charge across the constant-potential buses until taken from the rack by the user.

In the other 16 installations the series system of charging was used. Four of these were semi-self-service installations in which each man took his lamp from the rack but returned it to the lampman or, if the lampman was not on duty, placed the lighted lamp on a receiving bench.

With parallel charging each battery takes its needed charge from a constant-voltage supply independently of every other battery. The charging current automatically decreases as the plate voltage rises, until the battery is on trickle charge, where it remains until removed by the user.

With series charging each battery of a series receives the same charge irrespective of its need. To prevent unequal charging, all lamps of a rack or series are allowed to burn about the same number of hours so that the batteries will require approximately the same charge. As the batteries of each series become fully charged, they are taken off charge by the lampman or his assistant and remain off charge in the rack until used.

Lamps that are used on short or irregular shifts are placed in special racks away from the regular lamps or are lighted by the lampman at the regular shift time, or their burning time is completed by letting them burn in the lamphouse at the end of the shift.

Battery Electrolyte

There is daily loss of electrolyte from a storage battery through gassing on charge, spray from the gas vents, and sometimes actual spillage. The installations showed great differences in this respect.

Very little electrolyte was lost at four installations where filling and charging were controlled so as to give minimum gassing on charge and no spillage. These batteries were filled every 2 weeks. One lampman stated that his lamps would operate 3 weeks between fillings but that he found it better to fill them every 2 weeks, using less water per filling (approximately 1 ounce of water per lamp battery).

The lamps at the other 24 installations were filled weekly. Excessive spillage was found at 7 of these installations. Apparently spillage was due to overfilling of the batteries but occurred in different ways. At 4 mines it occurred chiefly in the lamphouse during charging; at the other 3 mines it occurred underground in low sections of the coal seam where the lamp batteries were nearly horizontal much of the time.

Numbering and Marking

All of the lamps were numbered, each battery carrying a number corresponding to its numbered position in the charge rack. At one mine the lamp numbers were the same as the pay-roll numbers.

At several mines the lamps carried other markings, such as distinctive colors painted on the battery jars to designate different lamp groups. The following groupings were observed: Day men and company men, working shifts, regular employees and extra men, and officials only. At one mine each employee's lamp check bears the same color marking as his lamp.

Instead of painting the batteries, one company marks its lamp groups by means of colored thumbtacks on the charging racks. This facilitates changes in the group marking but does not show the lamp marking when the lamp is away from the charging rack.

Plainly visible numbering on both lamp and charging rack is especially desirable in self-service installations. Even with good numbering, there is trouble in racking lamps because of carelessness, crowding (too many trying to rack their lamps at the same time), and inability of a few of the employees to read.

The problem is handled differently at different mines. A few lampmen get good racking by a system of penalties that make it worth while for each employee to rack according to instruction; those who can not or will not learn their numbers get someone else to rack for them.

Other lampmen obtain fair results with less discipline through voluntary cooperation of the miners plus personal inspection and rearrangement of the lamps after the men have left the lamphouse.

Two lampmen reported that steps were being taken to decrease crowding by installing railings so that the men would have to pass in single file past the racks. Man trips were used at both mines.

At one mine where self-service had been used, so much trouble had developed through careless racking, taking the wrong lamp, and inability of some men to recognize their numbers that self-service had been discontinued and the men were barred from the lamphouse.

All well-managed lamphouses have some scheme of indicating troubles that may have developed in the lamps; either a man reports needed repairs to the lampman or indicates the trouble on his lamp. A common method of indicating trouble is to knot the lamp cord. Thus a single loop in the cord may indicate headpiece trouble; two loops, a damaged cord; and a figure 8, battery trouble.

Such a system aids the lampman, makes each man more conscious of his lamp and more apt to take care of it, and insures his having a good lamp for the next working shift, but it has to be backed up by supervision and sometimes by penalties.

Repairs

The extent to which repairs are made in the lamphouse depends on such factors as the make of lamp, whether the lamps are owned or rented, the kind of rental contract, and the lampman.

Some lamps are designed for repair at the factory only. Under the terms of the rental contract renewal parts such as lenses, bulbs, and reflectors are replaced at the mine, but a lamp that develops trouble of any other kind is set aside until enough are accumulated, usually 10, to be exchanged for new lamps.

Other lamps are designed especially for ease of repair in the lamphouse. The degree to which these lamps are repaired in the lamphouse depends on the terms of the contract and the ability and attitude of the lampman.

Lamps that are owned are usually repaired in the lamphouse insofar as the facilities permit.

Records

An important part of a lampman's duties may be to keep a record of who uses the lamps and when, also of lamp performance, including failures and repairs.

At one self-service installation the lampman sat at a table and checked off each man as he passed on his way to work. Other lampmen take the record from the rack after the men go to work and a similar record of the returned lamps. This method allows the lampman to observe shift changes and be available to answer questions the men have regarding their lamps.

Records of lamps returned between shifts are useful for double checking with the time clerk, especially where a man has worked only part of the shift.

Self-service installations with no lampman do not obtain such records, nor are they obtained at lamphouses in which a lampman is not always on duty, as is shown by the stacks of returned lamps on the lamphouse benches sometimes accumulated over a period of several hours.

Light Distribution

In its approval of electric cap lamps, the Bureau of Mines places the following limitations on the light distribution.

> Except for inspection purposes, the area illuminated by the beam shall be free from sharp gradations in light intensity and spectral shadows, and the maximum candlepower of the light beam shall not be greater than 25 times the weighted average or mean candlepower of the beam.

This proportion of maximum to mean beam candlepower is called the light ratio. Each manufacturer of permissible electric cap lamps has available an assortment of reflectors that give light ratios of approximately 5:1 to 20:1 and polished reflectors of either plated brass or polished aluminum that give light ratios of 50:1 to 200:1 or more, depending on the sharpness of focus. The plated, polished reflectors are generally called "spot" reflectors. Because of the extra cost of polishing they are sold to the men for 50 to 75 cents each, whereas the diffusing reflectors are standard equipment without extra charge.

At 11 mines there seemed to be no restrictions on the use of the spot reflectors except the desire and ability of the men to buy them. They are obtained either through the lampman or at the company store.

At 11 other mines the use of spot reflectors was restricted to definite employees, including officials, inspectors, haulagemen, drillers, and machine operators.

The use of spot reflectors was not permitted at the remaining six mines, partly owing to the glare but chiefly to the discontent that their use creates among the employees. As one mine superintendent expressed it: "No two spots are the same and often cannot be made even similar. Each man that has a less desirable spot is a potential kicker." The more the lampman tried to help the men get better spots the more the demands on him increased until the management forbade the use of spot reflectors. These mines have found that the higher-ratio diffusing reflectors such as 15:1 to 20:1 are satisfactory wherever a more concentrated light is desired.

Changes in Lamp Design

The manufacturers of electric cap lamps are constantly attempting to improve their product to meet the demands of changing mine conditions. A lamp installation may include several modifications of a lamp. This is particularly true of rental installations in which lamps that fail are replaced by new ones. Such installations have no definite age, although the average age of the lamps probably remains virtually constant.

One installation included lamps of two manufacturers, as well as two models of one make. No objections were observed to the use of two models of the same make, but the use of lamps of two manufacturers in the same lamphouse is objectionable because few lampmen can be strictly impartial. In this installation the less-liked lamp was obviously "not getting fair treatment."

Lamp Performance

Various degrees of lamp performance were evident in the 28 installations. The lowest performance was noted where the lampman admittedly did not like his job or the lamps under his care. There was excessive spillage through overfilling of the batteries, excessive headpiece and bulb breakage due to lack of skill in assembling, and excessive lamp failures underground; all of these factors tended toward general dissatisfaction with the installation and abuse of the lamps. The results were unfair to the lamps and a reflection on supervision.

The next poorest performance was observed in five installations that had no regular lampman. Three installations were adjacent to hoistrooms and were cared for by the hoistmen as time permitted. Each hoistman was assigned some of the lamps to water and clean. The fourth installation was under the care of the electrician; the fifth was cared for by a yardman as part-time work. All were self-service installations in which self-service was used to eliminate a regular lampman and apparently to decrease supervision.

Next in performance were five self-service installations in which the lampman had other duties; however, someone was always on duty in the lamphouse when the work shifts changed.

Fair lamp performance was found at nine installations that had full-time lampmen but at which these lampmen, through lack of ability, supervision, or discipline, were not getting full performance from the lamps.

Exceptional performance was observed at eight installations. Five were operated upon a self-service basis, and three upon a semi-self-service basis. In each of these installations a good lampman was employed with an assistant in attendance when he was off duty.

In each of these installations the management used self-service to permit increased inspection and care of the lamps and, by maintaining adequate discipline, insisted on careful use and handling of the lamps.